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Research Notes : Evaluation of soybean germplasm collection for climatic conditions in Poland

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1) Evaluation of soybean germplasm collection for climatic conditions in Poland.

In 1974 studies were commenced to evaluate the variation in qualities and traits of soybean. The material covered a collection of 2412 entries including 275 varieties and 2137 genetic lines. The entries representing Maturity Groups (MGs) 00-IV were obtained from the following centers: U.S. Regional Soybean Lab., Urbana, Illinois, USA; Corn Breeding Lab., Hokkaido, Japan; National Agric. Exp. Sta., Hitsujigaoka, Sapporo, Japan; Weibullsholm Inst. Branch Sta., Fiskeby, Sweden; Dept. of Crop Science, Univ. of Guelph, Canada and Research Branch Canada Agric. Morden, Manitoba, Canada (41-58° northern latitude). They were all tested under field conditions in the vicinity of Poznan (51°30' northern latitude) in a full three-year cycle (1975-1977).

As expected, some of the entries failed to mature in particular years, others produced no seeds at all. Differences between the American classification of the MGs and our observations approximated 4-6 weeks. Evaluation of the collected forms was very rigorous. It resulted mainly from varying weather conditions characteristic of long rainless periods in late spring and early summer of 1975-1977. Another criterion for severe negative selection leading to removal of certain forms was the healthiness of plants. Approximately 40% of plants were removed due to viral and bacterial diseases.

After preliminary verification of rough results, 445 forms that matured in the field were taken for a synthetic evaluation including 11 morphological and developmental traits.

The range of variation within the analyzed traits was noteworthy (Table 1); e.g., the length of flowering period ranged from 7 to 63 days and that of growing period from 116 to 194 days. The plants were appreciably differentiated in height (21.0-152.0 cm) and in the height of the first pod formation as viewed from ground level (2.0-40.0 cm). Also, the seed yield parameters fluctuated (Table 1). Analysis of variance for the three years of study showed the values for certain traits to vary with years while the others to be less

Table 1

Variation of 11 soybean traits (1975-1977), Exp. Sta. Swadzim n. Poznan

Traits	Mean	Variance coefficient	Confidence interval	Range
1) Days to flowering	76.4	18.7	65.5- 66.7	56.0- 84.0
2) Flowering period, days	26.9	35.9	20.2- 21.7	7.0- 63.0
3) Maturity, days	169.6	12.4	140.7-143.3	116.0-194.0
4) Height, cm	72.9	30.9	46.1- 49.2	21.0-152.0
5) Branch, number	3.4	43.0	2.0- 3.2	1.0- 6.0
6) Height of 1st pod setting, cm	14.5	46.0	8.4- 8.9	2.0- 40.0
7) Pods, number per plant	24.4	43.9	24.3- 26.1	8.0- 54.0
8) Seeds, number per plant	40.1	48.3	38.6- 41.8	11.0-104.0
9) Seeds, number per pod	1.6	15.6	1.5- 1.6	1.1- 2.4
10) Yield per plant, g	6.2	58.2	7.4- 8.0	1.1- 21.2
11) Seed weight, g/100	15.4	35.0	19.5- 20.3	10.1- 36.0

dependent upon the climate, i.e., determined genetically to a large extent (Table 1). Worth emphasizing is the high stability of such a basic trait as growing period (the lowest variation coefficient 12.4%). The least stabilized trait was the seed/plant yield (variation coefficient 52.5%). Yet, the average seed/plant yield was 6.2 g which is considered satisfactory. Moreover, of the total population, 16.6% forms were selected whose seed/plant yield was above 9.1 g for the three experimental years. When growing 330,000 plants per hectare (at spacing 10 x 30 cm) the expected yield can be as shown in Table 2.

Early maturation was the major trait observed and on its background the variation of other traits was evaluated. Considering the mentioned discrepancies between the American classification of MGs and that in our climatic conditions, the 445 forms comprising population was conventionally divided into eight maturity groups (Table 3) and the groups tested for traits differing from each other significantly (Table 4).

The differentiation regarded primarily the date of bursting into flower, length of flowering period, and height of plants, besides the length of growing period. The groups I-IV (124-163 days of growing) were insignificantly

Table 2

Expected seed yield (kg/ha)

Yield per plant, g	Calculated seed yield, kg/ha	Number of items	Percent
≤ 3.03	1000	67	15.1
3.04- 4.54	1000-1500	71	16.0
4.55- 6.06	1500-2000	82	18.4
6.07- 7.57	2000-2500	85	19.1
7.58- 9.09	2500-3000	66	14.8
9.10-10.60	3000-3500	42	9.4
> 10.70	3500	32	7.2
		445	100.0

differentiated with respect to seed/plant yield. Between the remaining combinations of maturity groups statistically significant discrepancies were noted for a higher number of traits.

Another significant trait besides early maturation is the yielding capacity. On the basis of three-year observations, 50 forms were selected with a high and stable seed yield. The most promising are those characterized by a fair seed yield and satisfactory early maturity (growing period up to 140 days). Other forms represent very advantageous components for crossing.

A detailed analysis of the 445 forms revealed a number of interesting and significant correlations (Table 5). These make a very effective tool in the current selection work.

Observations made during flowering pointed to certain phenomena beyond the so-far gained knowledge of this species in Poland. Therefore careful examination of the process of flowering is continued.

The majority of analyzed soybean populations was characterized by determinate maturity ($\underline{dt_1}$). In many instances pods formed on the top fruiting node semi-determinated maturity. Leaf abscision at maturity followed the same pattern (Ab). Sporadically, single populations behaved differently.

Data for seed traits varied conspicuously, particularly those for the size. Seed weight, g/100 ranged from 10.0 to 40.0, sometimes from 50.0 to

Table 3

Maturity groups and characteristics of their traits

Maturity groups	Flowering period days	Number of items	Traits[a]										
			1	2	3	4	5	6	7	8	9	10	11
I	124-133	18	61.9	17.6	128.8	39.1	2.8	7.3	23.4	36.5	1.5	7.3	20.6
II	134-143	47	65.8	22.0	138.9	52.1	3.1	8.8	26.2	43.0	1.6	8.1	19.8
III	144-153	48	68.0	22.0	149.5	47.3	3.6	9.4	24.2	39.7	1.5	7.7	20.0
IV	154-163	33	66.6	28.0	158.6	65.3	3.2	9.8	27.9	48.0	1.7	8.3	18.3
V	164-173	36	68.3	32.0	170.0	76.2	3.0	10.8	30.8	54.7	1.8	9.2	17.6
VI	174-183	124	76.9	33.5	179.0	83.2	3.6	16.4	24.5	42.8	1.7	6.2	15.1
VII	184-193	129	88.3	33.5	186.0	84.5	3.5	19.9	20.1	32.5	1.6	3.5	11.1
VIII	194-	10	98.0	30.4	194.0	85.7	3.7	20.8	20.7	34.3	1.6	3.3	9.9

[a]For explanation, see Table 1, column 1.

Table 4

Traits differing particular maturity groups
(calculated upon multifactorial variance analysis)

Contrast	Maturity groups			Traits[a]
1	I	x	II	3, 4
2	I	x	II	1, 3, 4
3	I	x	IV	2, 3, 4, 8, 9
4	I	x	V	1, 2, 3, 4, 6, 7, 8, 9, 10
5	I	x	VI	1, 2, 3, 4, 6, 9, 11
6	I	x	VII	1, 2, 3, 4, 5, 6, 10, 11
7	I	x	VIII	1, 2, 3, 4, 6, 10, 11
8	II	x	III	3
9	II	x	IV	2, 3, 4
10	II	x	V	2, 3, 4, 6, 7, 8, 9, 10
11	II	x	VI	1, 2, 3, 4, 6, 10, 11
12	II	x	VII	1, 2, 3, 4, 5, 6, 7, 8, 10, 11
13	II	x	VIII	1, 2, 3, 4, 6, 10, 11
14	III	x	IV	2, 3, 4, 8, 9, 11
15	III	x	V	2, 3, 4, 7, 8, 9, 10, 11
16	III	x	VI	1, 2, 3, 4, 6, 9, 10, 11
17	III	x	VII	1, 2, 3, 4, 5, 6, 7, 8, 10, 11
18	III	x	VIII	1, 2, 3, 4, 6, 10, 11
19	IV	x	V	2, 3, 4
20	IV	x	VI	1, 2, 3, 4, 6, 10, 11
21	IV	x	VII	1, 2, 3, 4, 6, 7, 8, 9, 10, 11
22	IV	x	VIII	1, 3, 4, 6, 8, 10, 11
23	V	x	VI	1, 3, 4, 6, 7, 8, 9, 10, 11
24	V	x	VII	1, 3, 4, 6, 7, 8, 9, 10, 11
25	V	x	VIII	1, 3, 4, 6, 7, 8, 10, 11
26	VI	x	VII	1, 3, 6, 7, 8, 9, 10, 11
27	VI	x	VIII	1, 3, 6, 10, 11
28	VII	x	VIII	1, 3

[a]For explanation, see Table 1, column 1.

Table 5

Correlation coefficients

Traits[a]	1	2	3	4	5	6	7	8	9	10
1) Days to flowering										
2) Flowering period, days	-0.01									
3) Maturity, days	0.064xx	0.46xx								
4) Height, cm	0.28xx	0.44xx	0.57xx							
5) Branch, number	0.19xx	0.00	0.12xx	0.07x						
6) Height of 1st pod setting, cm	0.65xx	0.22xx	0.61xx	0.52xx	0.07x					
7) Pods, number per plant	-0.24xx	0.14	-0.16xx	0.07xx	0.29xx	-0.36xx				
8) Seeds, number per plant	-0.28xx	0.07xx	-0.15xx	0.12xx	0.23xx	-0.34xx	0.94xx			
9) Seeds, number per pod	-0.21xx	0.11xx	-0.04	0.16xx	-0.13xx	-0.09xx	0.19xx	0.42xx		
10) Yield per plant, g	-0.50xx	-0.12xx	-0.41xx	-0.09xx	0.02	-0.53xx	0.73xx	0.76xx	0.33xx	
11) Seed weight, g/100	-0.55xx	-0.33xx	-0.57xx	-0.38xx	-0.25xx	-0.53xx	0.05	0.05x	0.02	0.057xx

60.0 (Japanese varieties and genotypes). Differentiation in other seed traits fell within the so-far known cognizance.

Due to technical difficulties the collected forms were not assayed for protein and oil levels. Randomly, several dozen analyses were carried out. The protein level tended to be above 40% and the oil level above 16%. Also, initial screening was made for the presence of alleles of Kunitz trypsin inhibitor (SBTJ-A_2) and for alleles controlling the absence of the latter (Ti°). This work has been continued with particular stress on establishing the genetic model of these phenomena, for use in breeding programs.

The data on 445 soybean forms, selected from field trials with 2412 varieties and lines in the years 1975-1977, revealed a wide variation range in phenological and morphological traits, as well as in seed yield parameters. They provide information about fairly large gene resources, sufficient to meet our present day breeding needs. Many lines are subjected to direct selection and tested for seed yield under strictly experimental conditions. The so-far available data for yielding capacity are regarded promising since the seed yield scores range from 1500 to 3000 kg/ha. Other forms which, along with distinct and economically valuable traits (e.g., high yielding capacity, good morphotype), carry less advantageous traits (late maturation), have been included into a complex crossing program.

The first stage of this program aims at suppressing the specific correlation between the early maturation and plant height. The very early forms are generally shorter and tend to set pods low, while medium and late maturing represent a very prospective morphotype. They are higher and have a relatively advantageous harvesting space. It seems that a recombination of the promising qualities and traits will be possible.

The three-year studies under varying weather conditions helped to a large extent to establish and/or set apart the genetic determination from the random variation. It appears that good grounds have been provided to expect a prospective recombinant variation from crossing.

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1) General ideas about soybean genetics.

I have seen pubescence, especially in nature plants, in brown color against gray color. The two types are equally frequent among commercial varieties. In brown pubescent genotypes the hairs in the young plants are colorless, but after a few weeks' growth, many of the hairs grow on the stems and pods and to a lesser extent on the leaves with brown pigments. In gray pubescent varieties only a few brownish hairs are formed and most hairs are without pigment, giving a distinct gray appearance to the fields of this kind of variety.

Black and brown pigments may occur in the outer layer of soybean seed coats in varying amounts and patterns.

In a few varieties the chlorophyll is retained in the ripe seed and also the leaves and pods; they don't turn yellow during ripening. This results in seeds that are green through, including cotyledons, embryo, axis and seed coat. This trait is often apparent at earlier season since leaf tissue killed by diseases or other factors doesn't turn yellow as in other varieties.

A coat, whitish or brownish bloom, occurs on some seed coats. Soybean, especially the young dark-seeded hay varieties, have a thin layer of apparently